ART. XXIII.—*A New Anthropometer, or a simple Apparatus for Determining the Inequalities of the Length of the Legs.* By B. F. GIBBS, M.D., Surgeon U. S. Navy, and Fleet Surgeon South Pacific Station. (With two wood-cuts.)

IN a case of fracture of the femur, on board of the U. S. Flagship "Richmond," at Talcahuano, Chili, on the 7th of March, 1875, and which was treated on board ship, there was some shortening. The results of the use of the tape-measure were unsatisfactory. The man was coloured, and no marks could be made on the skin with the nitrate of silver, at the points usually selected for comparative measurements of the two limbs. The difference given by the tape was a half of an inch, which was contradicted by the man's very steady walk. As I had taken much pains in the treatment of this case, and had used the ordinary Liston's splint, in connection with canvas stretched over a wooden frame for handling the patient, I was desirous of finding as accurately as possible the exact difference in the length of the legs.

I accordingly devised a very simple apparatus for measuring the inequalities of the length of the legs, which can be made by any skilful carpenter, and which is fully represented in the annexed diagrams, Figs. 1 and 2. It mainly consists of three parts, viz.: A board one inch thick, five feet long, and twenty-two inches wide; two sheet-iron hooks, E and F, Fig. 1; and a sliding square, C. The board has a longitudinal slit or opening exactly in the median line, one and a half or two inches wide, and beginning at twelve inches from the upper or pelvic end. The back of the boards (as it will be made of two ordinary boards) is supplied with six battens, to preserve the rigidity of the apparatus and integrity of the open slit, and which are represented by the transverse dotted lines.

The transverse piece C is placed so as to be rectangular to the median line of the board, and is screwed firmly to the slide D, which by careful adjustment is made to move accurately in the longitudinal slit. Toward the upper part of this slit there is also another slide, A, to which is attached a small piece of board placed upright, and of the following dimensions, viz.: six inches long, seven inches deep, and one inch thick, and marked B. This is a perineal block which is intended to finish the adjustment of the median line of the pelvis to that of the board.

The hook-like pieces made of sheet- or boiler-iron, figured in the diagram, Fig. 1, as E and F, have a pivotal centre, as represented in the perspective view of the same in Fig. 2, at which point they are secured to the board by a single "wood-screw." The latter figure also shows the iliac blocks, which are cut from a white pine board one inch thick, and screwed to the sheet-iron, the screws entering from the under face.

Fig. 1.

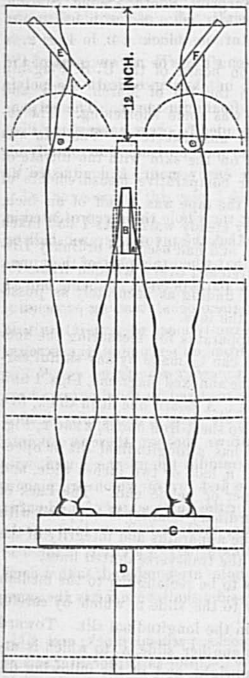
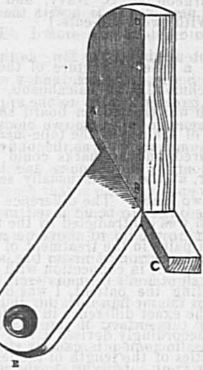


Fig. 2.



Of the irregular-shaped pieces of sheet- or boiler-iron, an outline of which is represented in Fig. 1, there are two, one for each hip. These sheet-iron pieces I have called for convenience iliac hooks, A, B, C, E, and the pieces of wood represented attached to them, A, B, D, in Fig. 2, the iliac or hip blocks. These being attached to the board by the screw mentioned, which is also the fixed centre of a circle, and which is located near the end of the broad part of the hooks (E, Fig. 2), it is evident that the other ends of the hooks, and the iliac blocks attached, describe the circles. The value of the whole apparatus depends upon the establishment of these two centres. The circles which are produced, with these points as centres, when described on the board with a pair of dividers, must cut each other at exactly the same point in the median line of the board, and which is a simple matter of measurement. The whole of the iliac hook and block, as represented in Fig. 2, would go on the left-hand side of the board, if one were standing at its foot and looking towards its upper or pelvic end.

The broad parts of the iliac hooks are two inches wide and eight inches long. The narrow parts of the same (A, B, C, Fig. 2) are one inch wide and seven inches long. In cutting these from the sheet-iron, this narrow part, A, B, C, Fig. 2, must stand at an angle of 45 degrees with the broad part, and as represented by the diagram, Fig. 1. The perpendicular edge of the block, B, D, represented in Fig. 2, bears a constant parallel relation with the perpendicular edge of the block on the opposite side of the board. The base of the block A, B, in Fig. 2, is not intended to be as long as the whole length of the narrow part of the hook, because the free end B, C, Fig. 2, in passing beneath the pelvis gives greater solidity to the apparatus in final adjustment. The perpendicular edges of these two blocks are intended to press against the iliac crests on each side, as the body lies in proper position horizontally on the board. Both hooks and blocks are easily made, and adjusted as follows :—

The object to be achieved in attaching the whole thing represented in Fig. 2, to the board above described, is, that the pivotal screws shall be placed in certain points in the board, so that when this part of the apparatus, right and left, shall describe sufficient parts of circles in being moved toward the median line, the iliac faces of the blocks, standing perpendicular to the surface of the board, shall exactly meet at a point in this median line which is exactly equidistant from either one of the screws. Under these conditions, the apparatus is in *perfect adjustment.*

The points at which the pivotal screws are fixed in the diagram, Fig. 1, are six inches from the median line of the board, and twelve inches from its pelvic or upper end. A line drawn through these two points across the board at right angles with the middle line of the board, will mark the first of a series of peg holes, the first two of which are placed a half an inch from the ends of this line, or the outer edges of the board. These holes are continued in a semicircle, made a half an inch apart, and numbered up to 20. The radius of this, a part of a circle, is the distance to the above first peg-hole. These holes are numbered, so that each two of corresponding numbers on either side, shall be exactly the same distance from the median line of the board.

Having now the board with the iliac blocks, perineal block, and sliding square, all of which could be made by a skilful carpenter after securing first the iron hooks, almost as quickly as it has taken to describe them, we have to discover the application by adjusting the body of the person to be examined. This is done by drawing widely apart the iliac hooks, and directing him to sit on the upper end of the board so that the iliac crests shall be five or six inches below the upper end of the board. With one or two movements up or down, to right or left, done by the person himself, the iliac blocks are easily adjusted so that their perpendicular faces shall press equally against the iliac crests, and if the body is in the median line of the board, the pegs will occupy holes of corresponding numbers on each side, securely fastening the faces of the blocks.

These blocks, in their perpendicular position, will be found to form an angle with the line of the iliac crests of about 30 degrees, so that in no instance can there be a failure in finding a bony point of resistance. The crest-blocks being adjusted, the perineal slide and block is pushed up, which further secures the body in the median line.

We have now the pelvis in a rectangular position, as well as the heads of the femurs and the trochanterian prominences, if the parts are normal. It may just here be as well to meet a possible objection to this apparatus by noting that it is seldom a deformity of the pelvis is sustained in the iliac bones, even in abnormal structures in which there has occurred disease of the bones later in life. In those female pelves which have never been fully developed, the deformity almost always exists in the ischium or pubis, and seldom in the heavier ilium. That distance may be considered as constant in the skeleton, between the upper edge of the acetabulum and the crest of the ilium, as in any other part of the osseous tissues. This constancy is indeed practically admitted by the custom of taking the anterior superior spinous process of the ilium for one of the reliable points for tape measurements in any comparison of the legs.

If the pelvis and heads of the femur are caused to assume, by this apparatus, a perfectly transverse position on the board, they are of necessity in a rectangular position with the sliding square at the lower end of the board, as well as with the lower extremities, if there is no abnormal inequality in the length of the limbs. The legs being now separated so that the heels rest just external to the blocks, represented on the transverse slide, and which places the heels ten inches apart, there will be seen at once any inequality, if such exists. The plantar surfaces being so soft as to yield readily to the pressure of the transverse square, a more perfect comparison of the length of the limbs may be made by having the person to wear a pair of snugly-fitting shoes having the same thickness of soles. The toes naturally fall outward when the feet are placed against the square, but they should be held fixed as nearly at right angles as possible with the line of the leg, so that only the heels come in contact with the square.

A difference of an eighth of an inch can easily be seen with this apparatus. With one more perfectly constructed, having metallic guides, set screws, peg-holes, etc., even much greater accuracy can be achieved. Any one having used this apparatus would be exceedingly unwilling to go back to the guess-work of the tape measurement in which no two people will secure similar results from the same experiment. The statistics of fracture of the femur would at once be more valuable, if the measurements were taken by an apparatus of this description, and the comparative values of the different modes of treating fracture of the femur could then be decided as they only can by a more uniform system of measurement.

The accuracy of this instrument, if carefully constructed, may be further relied on in matters of diagnosis, and more particularly in that of fracture of the neck of the femur. Not a few good surgeons in their professional lives have been puzzled in making a differential diagnosis between fracture of the neck of the femur and dislocation of the hip joint. Nothing would seem easier, and yet fracture of the neck has occurred without shortening or eversion of the foot. Intra-capsular fracture of the neck of the femur is known in one way by observing the trochanter to move on a shorter radius than on the sound side. This is the case whether there be shortening or not. Hence, one of the points in making this diagnosis is to observe whether the trochanter approaches the median line of the body in the direction of the axis of the neck of the femur. The diagnosis in case of impacted fracture is difficult where there is no perceptible shortening, no crepitus, no eversion or abduction. The rectangular position of the pelvis in such cases, when placed on this apparatus, will have exact relations with the ends of the lower extremities, and most extraordinary advantages will be found for determining the existence of this fracture.

The adjustment for this purpose is easily made by properly placing the body on this apparatus so that there will be a correspondence of middle lines, and the trochanters shall be equidistant from the centre. If in the measurement with a carpenter's square and rule, there should be seen a marked difference in the distance of the trochanters from the median line, or the same thing from the outer edges of the board, the existence of a fracture would be clear. It would show that there was a shortening of the neck of the femur, and this without any shortening of the length of the limb.

It was exactly this kind of measurement, as a means of diagnosis, which was brought forward at a meeting of the Royal Medical and Chirurgical Society, Dr. C. J. B. Williams in the chair, and published in the *Lancet* for 13th of February, 1875. A paper was introduced by Mr. Thomas Bryant on the diagnostic value of the Ilio-femoral Triangle in cases of injury of the hip in impacted fracture, and in interstitial absorption of the head of the femur. This paper set forth the means of constructing this right angled triangle. Its reliability as a means of diagnosis seemed to have been in direct proportion to the accuracy with which a line could be let fall perpendicularly from the anterior superior spinous process of the ilium, to another line which was practically drawn from the great trochanter of one side to that of the other. The outer ends of this transverse line, on each side, between the intersection of these perpendiculars and the trochanteric processes, if there were found a normal condition of the parts, should be found equal. Of course the two remaining sides of the two triangles should be equal. The proof of an abnormal condition of the parts is decided by this test, when there is found a difference in the length of the base lines above referred to. In healthy adults, Dr. Bryant found the normal length of this base line two and a half inches, and in cases of impacted fracture, it might be from one-half to one inch less.

The least reflection it seems to me ought to show that all this triangulation of the surgical region is attended with great uncertainty when performed by unskilful hands, and even with the greatest accuracy, the same person would not probably secure the same results upon two consecutive trials on account of the uncertainty of the "fixed points." No skill is required to fix the pelvis on the apparatus in hand, and the same results can be secured consecutively with very little care, as the rectangles formed are purely mechanical.

The careful admeasurement of a number of sound men with a view of testing the normal symmetry of the two sides resulted in showing the perfect accuracy of my rather crude apparatus. When the pelvis was placed in position, the sliding square showed no difference in the length of the limbs. This was a multiplied test for the instrument. On the other hand, the case of fractured femur, mentioned at the beginning of this paper, showed that the treatment had resulted in shortening of a little over one quarter of an inch, instead of one-half inch, as three different surgeons had concluded from the most accurate tape measurement. In conclusion, I would recommend surgeons who have occasion to use this kind of anthropometry, to prepare this rigid apparatus, and use it in preference to the tape measurements, made from badly defined anatomical points.

Art. XXIV.—*Description of an Apparatus devised by Dr. Thomas G. Morton for Measuring any Irregularity in the Length of the Lower Extremities.* By Stacy B. Collins, M.D., Assistant Surgeon of the Orthopædic Hospital, Philadelphia. (With a wood-cut.)

In attempting to accurately estimate the shortening which may take place after fracture, coxalgia, etc., it seems necessary to have—First, a simple instrument that can be used on a patient in bed without disturbing any applied apparatus. Second, to have it of material which cannot be stretched. Third, to have both limbs measured from one fixed point, thus avoiding inaccuracies resulting from obliquities of the pelvis, differences in height of the iliac bones, and similar causes. Fourth, to have an instrument that not only shows the inequality, but accurately measures it at the same time.

To meet these requirements, Dr. Morton, one of the surgeons of the Pennsylvania Hospital, introduced into that institution several years